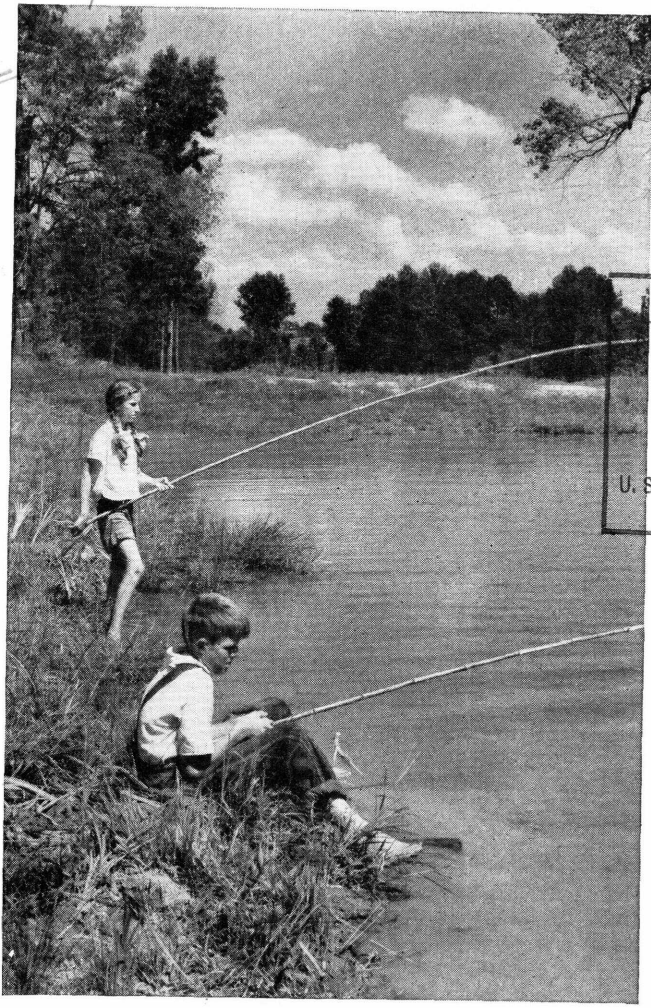
Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

984F
Cop. 2



FARMERS'
BULLETIN
No. 1938

FISH FOR FOOD from farm ponds

U. S. DEPARTMENT OF AGRICULTURE

MAKING the best use of every acre is the foundation of a sound farm-conservation program. Where a suitable site for a farm fishpond exists, no better use can be made of such land than to develop it for the production of an ample supply of fish for the farm family. This is especially true in wartime, when home production of food is more important than ever, and a well-balanced diet is essential to meet the unusual demands of total war.

Fresh fish taken at any time from a readily accessible farm pond can form an important part of the country diet. Thousands of farms have suitable fishpond sites which, if properly developed and managed by farmers, would provide both pleasure and profitable returns to more than a million farm people.

This bulletin explains how fishponds can be constructed with the equipment and materials ordinarily available on farms and how such ponds can be managed to encourage rapid production of an ample supply of fish for farm use. The information will be useful to individual farmers and to those groups that have formed soil conservation districts for a united attack on soil and water conservation problems. Although the management methods discussed are based on experience in the Southeast the same principles, with slight changes in specifications required by local conditions, are applicable in many other parts of the country.

Washington, D. C. **Issued May 1943**

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. - Price 10 cents

FISH FOR FOOD FROM FARM PONDS

By VERNE E. DAVISON, *Senior Biologist*, and J. A. JOHNSON, *Associate Biologist, Biology Division, Soil Conservation Service*

CONTENTS

INTRODUCTION

FISH as food and fishing as an occupation have had tremendous influence on human lives throughout the ages. From the coastal area of the United States alone more than 3 billion pounds of marine fish are ordinarily harvested every year.[1] These are consumed as fresh fish within 200 miles of the coast and in the larger cities and towns. Elsewhere they are available as frozen, salted, pickled, dried, and smoked fish. In spite of the large quantities of fish taken from coastal waters, the average farm dweller seldom has fresh fish on his family table and is not likely to unless he produces them on his place. By way of contrast, French farmers for centuries have eaten fish produced on flooded grainfields as part of a regular crop rotation.

Many farms have suitable sites for the construction of ponds. These sites, properly developed and managed for fish, will contribute substantially to better living on the farm; a single acre of pond can be made to yield 350 or 400 pounds of pan-size fish annually. Farmers in the Southeast alone could profitably produce on their own farms some 60 million pounds of fish each year at a cost of only a few cents a pound. Foods from field crops or livestock are produced no more economically.

Fresh fish in farm diets not only helps to promote proper development of growing children, thereby contributing to the strength and soundness of the Nation's rural youth, but also improves the health and capacity for work of adults everywhere (fig. 1). The annual consumption of meats, including red meats, fish, and fowl, in the United States averages 163 pounds per person.[2] Of this total, only 15.3 pounds consists of fish. Something like 163 pounds of meat is needed to maintain health and vigor. In the Southeast, however, most farm people eat less than 154 pounds of meat, and this consists principally of pork and poultry. One acre of a fertilized pond (see p. 6) will produce two or three times as much meat as the average person consumes. Fish, of course, should not replace all other meats

[1] United States Fish and Wildlife Service. FISHERIES OF UNITED STATES AND ALASKA, 1940. U. S. Dept. Interior Current Fisheries Statistics 27, 6 pp. 1940. [Processed.]
[2] Bureau of Agricultural Economics. Estimated average annual per capita consumption, 1935 to 1939.

but can be used to supplement them, adding pleasant variety and many essential food elements to the diet. Fish is a good source of proteins and fats. It is high in phosphorus and contains substantial amounts of calcium and iron. Niacin and vitamins A, B, and C also are present.

R2-907

FIGURE 1.—Fresh fish in farm diets promotes proper development of growing children and improves the health and capacity for work of adults.

Under the stress of war production and during the period of economic and mental readjustment in returning to peace, as well as in normal times, families on the land need recreation. That afforded by a good fishpond is hard to surpass (fig. 2).

HOW TO MANAGE FISHPONDS

The life and usefulness of a farm pond depend to a large extent on how it has been built and whether lands surrounding the pond are adequately protected by soil conservation measures. The work and expense of building the pond, stocking it with fish, and managing it will be wasted unless the watershed is protected against erosion. When silt fills a pond it becomes useless, and often the only suitable pond site on the farm is ruined. Now that effective erosion-control measures have been developed, silting can be held to a minimum.

FOODS OF BREAM AND BASS

Pondfishes depend for food almost entirely on the tiny insects that live within the pond itself rather than on those that fall into the water or are caught while flying close to its surface. Contrary to a common belief, pondfishes do not feed to any great extent on water weeds that float on or are above the surface. The bluegill bream, for example, depends almost entirely on aquatic insects for food. The capacity of a pond to produce bream is limited, therefore, by the number of water insects present.

These insects, too, must have food, but where the water is muddy their food is limited. The tiny single-celled plants called algae, of which there are several kinds, furnish the principal foods of aquatic insects. These plants are so small that they can be seen only with a

magnifying glass. Although algae have several colors the green forms are most important in fishponds. The abundance of algae in ponds depends on the action of sunlight in combination with the water and the mineral elements that are in the water. These plants grow faster when reached by sunlight than when the sun's rays are obscured, just as do cotton, or corn, or garden crops. While most land plants obtain moisture and minerals from the soil through their root systems, the algae obtain minerals and moisture directly from the water in which they live, taking them through their body walls. Sunlight and temperatures affect the green coloring matter (chlorophyll) and life processes in algae just as they do in cotton or trees. Since muddy water prevents sunlight from reaching the floating algae, it is evident that the basic foods for fish production are dependent upon waters that are largely silt-free.

Only bream, such as bluegill (*Lepomis macrochirus*) or other sunfishes, and large-mouth black bass (*Huro salmoides*) are recommended for small ponds; because this combination is the simplest to manage. Some landowners would like to include catfish, crappie, and other kinds, but experience has shown that mixing these species with bream and bass seldom produces good fishing. Satisfactory combinations of these may be developed in the future, but in the meantime bream and bass may be relied upon for excellent fishing. The successful management of bream and bass, however, requires an understanding of their principal foods and how the fish grow, live, and reproduce.

It takes considerable food to grow a pound of fish—or a pound of cotton, or beef, or pork, for that matter. Bream, as previously explained, depend almost entirely upon aquatic insects for food. They eat few young fish and almost no leafy water plants. Moreover, since insects feed on single-celled algae and the abundance of these plants depends upon plenty of sunlight and mineral foods, it is necessary to increase the natural fertility of clear waters to produce more bream.

There is, however, still another important factor in growing bream for fishing. The number of fish must be regulated. Each female produces about 3,000 or 4,000 young a year, but it is impossible to supply food enough for all of them. Carnivorous species such as bass, which feed largely on small fish, take care of this in the wild. Likewise, the farm pond must have a similar check against overpopulation, and this is accomplished by stocking it with large-mouth black bass, regardless of how small it may be.

Every fisherman can recall ponds which contained thousands of bream little larger than a minnow. No matter how often the fisherman returned year after year, the bream seemed as numerous as ever but no larger. When fish are too plentiful they usually get only enough food to remain alive and not enough for growth. They may never reach a desirable size, as even a moderate overpopulation tends to retard growth. Yet, in properly managed ponds in the Southeast, both bass and bream attain pan size in a single year.

Ordinary ponds, according to investigations made by the Alabama Agricultural Experiment Station, contain enough food to produce and support from 40 to 200 pounds of bream and bass for each surface acre of water, depending upon the fertility of the watershed.[3]

[3] SWINGLE, H. S., and SMITH, E. V. MANAGEMENT OF FARM FISH PONDS. Ala. Agr. Expt. Sta. Bul. 254, 23 pp., illus. 1942. The assistance of the authors of this publication in making available experimental data and reviewing the present bulletin is appreciatively acknowledged.

R2-091

FIGURE 2.—Fishing in their own pond gives a measure of satisfaction to the farm family.

Through experiments with the use of commercial fertilizers the station has been able to increase the amount of food in a pond, thereby increasing the quantity of fish a pond is capable of producing and supporting. The experiment station also determined the correct numbers of bream and bass for stocking new ponds that are to be fertilized.

STOCKING THE POND

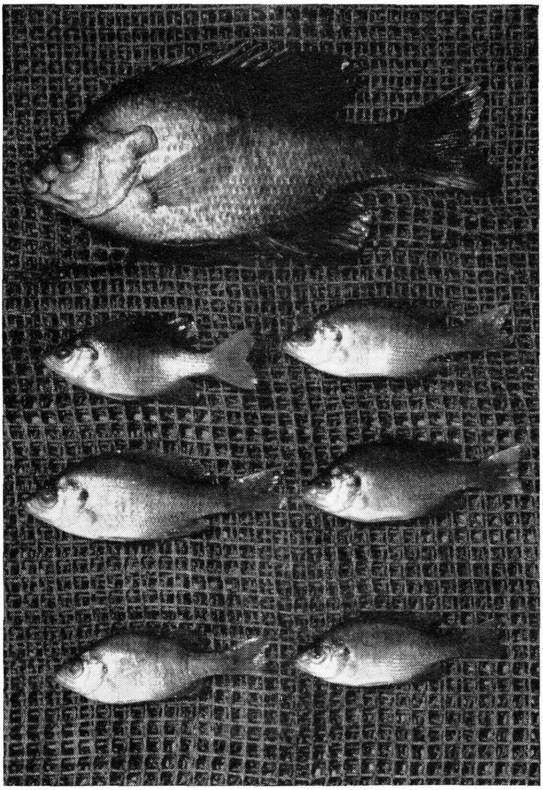
A successful fishpond will provide good fishing within 1 year of stocking and, with proper care, will continue to do so year after year. The initial stock of fish, both in kinds and numbers, greatly influences its chances for success as a fishpond (fig. 3).

Bluegill bream grow rapidly if they have plenty of food. Bream weighing one-fourth pound are produced in 1 year in fertilized ponds stocked with 1,500 bream and 100 large-mouth bass per surface acre of water, whereas six times this number (or even more) of very small bream are produced if ponds become overstocked, as shown in figure 3. The 100 bass reach an average weight of 1 pound in one season and are necessary to keep the bream from becoming too numerous.

The problems of supplying food and controlling excessive numbers of fish can be illustrated by the following example:

Suppose a 1-acre pond has enough natural fertility to produce, say, 120 pounds of fish. The pond would grow 480 fish to about one-fourth pound in size, that is, large enough to use. On the other hand, twice this number, or 960 bream, would reach less than half this size and be

too small to use but large enough to spawn additional thousands. The pond cannot be stocked with bream or bass alone because the bass without the bream would have insufficient food and the bream without the bass would increase to such an extent that satisfactory growth would be impossible. So it is apparent that the 120 pounds of fish must be divided between bream and bass in a ratio that will stay fairly constant year after year. In this 1-acre pond approximately 400 bream



R2-916

FIGURE 3.—The large bream obtained sufficient food to reach pan size within a year, but the small ones failed to grow because they were crowded in a pond where there were too many fish for the amount of food available.

and 25 bass would be needed. For a 1-acre pond fertilized correctly for maximum fish production, 1,500 bream and 100 bass are needed, because of the resulting vast increase in food. The size of the pond should be figured to the nearest tenth of an acre and stocked proportionately.

The initial stock desirable for a pond may be obtained from Federal hatcheries, or, in some cases, from State hatcheries. An application should indicate definitely the exact size of the pond and the number of bream and bass desired; also whether or not the pond will be fertilized. Farmers cooperating with soil conservation districts may obtain fish for stocking through their district organization.

Bream are usually delivered by the hatcheries in the fall (October to December). Both bream and bass fingerlings may be stocked then, and they should be of about equal size when placed in the pond. Bass fingerlings are not always available in the fall, but in that case bass fry (newly hatched fish) can be added the following spring. This delayed stocking of bass is satisfactory except that fishing the following fall must be limited largely to bream as the bass will not spawn until the next year. Part stocking, such as introducing only two-thirds or less of the recommended numbers of either bass or bluegill bream, is not satisfactory. Bass should not be placed in a pond before the bream. It is equally important that the stocking of bass should not be delayed beyond May or June of the first year following the stocking of bream.

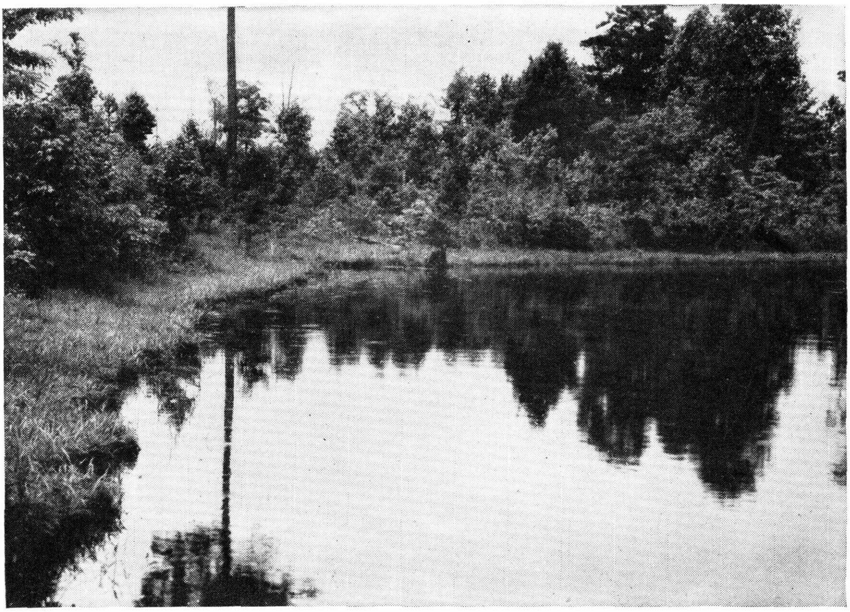
APPLYING FERTILIZER

Either commercial or organic fertilizers will build up the food supply so that each surface acre of a pond will support from 400 to 600 pounds of fish. As previously explained, the increase of food in a fertilized pond is derived directly and indirectly from a tremendous growth of plants so small that they can be seen only with the aid of a magnifying glass. These single-celled algae float in the upper 3 feet of the pond surface. They are present in such numbers as to give the water a light-green or brown tinge, depending on the kinds of algae.

Soils on the watersheds above ponds are very frequently deficient in plant-food elements. Pond waters are, therefore, more or less deficient in nitrogen, phosphorus, potash and, except in limestone areas, in lime, depending on the condition of the surrounding lands. To compensate for these deficiencies in the water, the Alabama Agricultural Experiment Station recommends an application of 100 pounds of 6–8–4 mixed fertilizer (NPK), plus an additional 10 pounds of nitrate of soda for each surface acre of water. This application should be repeated at intervals, from spring until fall. For those who wish to mix their own fertilizer the Alabama station recommends the following formula for an acre of pond:

40 pounds of sulfate of ammonia.
60 pounds of superphosphate (16 percent).
5 pounds of muriate of potash.
15 pounds of ground limestone.

As fertilization during the winter months yields only minimum returns, the first application should be made as soon as the water warms up in the spring. In various sections of the Southeast this will vary from March to May. Two or three initial applications are made at weekly intervals in a new pond and thereafter only when algal growth in the water becomes reduced to such a degree that the bottom can be seen where the pond is 18 inches deep. This occurs ordinarily about every 3 or 4 weeks. Applications are stopped in October or November, when cool weather reduces fish growth because of lower temperature. Fertilizer is applied to small ponds from the edge, being broadcast toward the center. It is not necessary to cover the entire surface, as wave action will distribute the food elements. Placing fertilizer near the bank in shallow water should be avoided as this encourages too rapid growth of grasses and weeds on the edge.



R2-300

FIGURE 4.—When the pond site is cleared, a strip above the normal water level should also be cleared of trees and shrubs.

CONTROLLING WEEDS

Leafy aquatic plants are not desirable in fishponds managed according to the methods outlined in this bulletin. This includes all kinds of water weeds such as cattails and waterlilies, which emerge above the surface, and coontails and similar submerged plants that so frequently fill ponds. They should be kept out by some method or other. Pond weeds foster the breeding of malaria-carrying mosquitoes; hinder bass from preventing an overpopulation of bream; utilize the fertilizer placed in a pond without greatly increasing food for fish; and interfere, as fishermen well know, with fishing. The vast increase of algae resulting from applications of fertilizer colors the water and, by cutting off sunlight, keeps underwater weeds from becoming established.

Fertilizer does not prevent emergent plants such as pond lilies, cattails, and parrotfeather from rooting in shallow water. For this reason the pond should be deepened at the edges, as explained in a later section of this bulletin. Where it is not practical to deepen the edge it becomes necessary to inspect the shallow areas frequently and to remove volunteering plants. This is not difficult if individual plants are pulled before they spread into colonies. An ordinary potato fork is an excellent tool for this purpose. When left undisturbed, shallow-water plants soon become heavily rooted and more difficult to eradicate.

Fertilizer, then, accomplishes two outstanding things in pond management: First, it vastly increases the food for fish; and, second, it materially assists in the control of submerged pond weeds. For these reasons builders of new ponds are strongly encouraged to include fertilization in their plans.

515938°—43——2

Weeds and brush must also be controlled on the banks of the pond. A strip at least 15 feet wide should be cleared next to the water's edge and should be mowed as frequently as necessary to maintain it in low herbaceous cover (fig. 4).

FISHING THE POND

When ponds are stocked with the proper kinds and numbers of fish and fertilizer is added regularly each year, heavy fishing is possible;

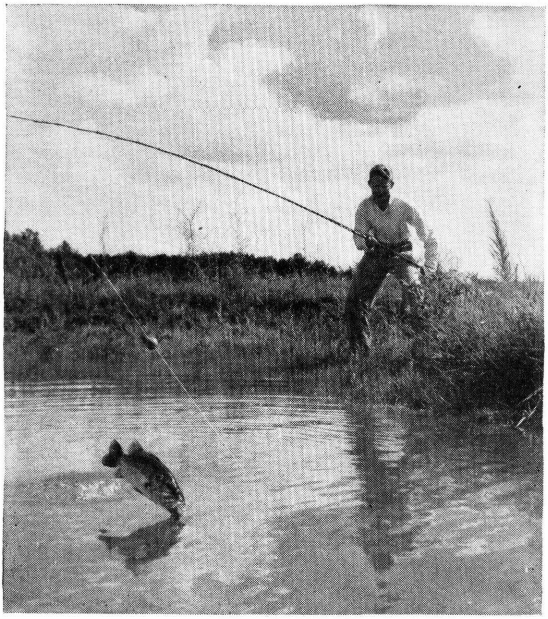


FIGURE 5.—Fish is one farm crop that it is fun rather than work to harvest.

in fact, it is necessary. Good management should include a definite effort to remove as many pan-size fish each year as convenient so that young fish under this size can obtain plenty of food to bring them, in turn, to usable size. Failure to do this results in a waste of fish and fertilizer. This is one reason that it is so important to have a pond of the right size. One that is too large for the farm needs is either wasteful or proves a burden. Good management means removing from a 1-acre fertilized pond, by hook and line, something like 40 or 50 one-pound bass and about 600 to 800 one-fourth-pound bream, a total of from 200 to 250 pounds of fish each year (fig. 5).

This will provide food at the rate of 4 pounds of live fish per week. The average person consumes about a pound of beef each week; so farm ponds are capable of adding materially to the family diet, not only in the quantity of food, but also in valuable food elements.

H. S. Swingle and E. V. Smith, of the Alabama Agricultural Experiment Station,[4] have found by fishing fertilized ponds that—

When the number of fish in the pond is reduced, the food for those remaining increases, and as the food per individual increases, the fish bite less often. During

[4] Ala. Agr. Expt. Sta. Bul. 254, p. 18. For complete reference see footnote 3, p. 4.

this period of poorer fishing, the fish grow rapidly; as the maximum weight which the pond can support is approached, the fish bite more and more readily, and fishing once again becomes "good." Alternating periods of good and poor fishing are therefore to be expected in all ponds which are adequately fished.

DRAINING THE POND

Landowners sometimes wish to harvest the maximum number of fish produced. They may want to share the fish with neighbors and friends at a community fish fry or to harvest large quantities for some other purpose. In such cases draining the farm pond is the most satisfactory means of obtaining all the pan-size fish. Fertilized waters yield something like 350 to 400 pounds of usable fish per acre. The remaining fish are usually too small to eat.

Draining is not a difficult job. The reservoir is allowed to drain to about one-fourth of its capacity. Then careful attention must be given as the remaining water drains from the pond. The fish are collected below the dam when they come through the pipe. Collecting fish and sorting them is greatly facilitated by the use of a fish trough that can be simply constructed with hardware cloth on a wooden frame. The open end is fitted over the drain opening below the dam. It should be placed about on the level, so the water will drain from the sides quickly.

Frequently all the fish caught when the pond is drained cannot be used immediately. In communities where cold-storage food lockers are available, excess pan-size fish can be kept in a frozen condition for future use. If a small auxiliary pond is available, a good many fish can be held there for a while.

Enough small bream and bass will be found to restock the pond if it is drained in the fall. Bream and bass used for restocking should be as near the same size as possible so that the bass will not eat the bream. It is only necessary to place the correct numbers of each in a holding pond until the main pond partly refills. Fertilizing the holding pond while it is being used for this purpose or for raising minnows for fish bait is advisable.

Now and then, something may happen to destroy the balance between bass and bream or between large fish and smaller ones in a fishpond. Trespassers may seine the pond or for one cause or another the owner may not fertilize it for a season. If the pond fails to produce excellent fishing any year after the first season, something is wrong; but where an adequate drain has been provided, it is a simple matter to drain and restock.

HOW TO BUILD A GOOD POND

The following recommendations explain the fundamental measures of pond construction that are essential in laying the foundation of a lasting pond and insure adequate fishing for the builder and his family.

It should be kept in mind that about 40 or 50 one-pound bass and 600 to 800 one-fourth-pound bream, which are sufficient for the average family, may be caught annually from each acre of a well-fertilized pond. These figures are based on an estimate that about half the number of legal-size fish can be caught by hook and line. A pond to be used by several families would, of course, have to be

proportionately larger than an acre, but unless the owner wishes to allow many friends to fish in his pond or wishes to sell fishing rights to others, it is best to hold rather close to a standard of 1 acre for each farm family.

CHOOSING A LOCATION

The most desirable sites are small valleys with steep sides and gradually sloping floors (fig. 6). Such sites are frequently used better as wildlife land than for cultivated crops or pasture. Even on small areas suitable for pasture or woods, a fishpond often provides better use of the land. Deep water at the edges makes it easy to keep emergent water plants from becoming established. A gently sloping valley floor makes it possible to impound a sizable area of water with a dam of moderate height. Such a pond, however, should be at least 3 or 4 feet lower than the fields; otherwise the water table may be raised to a height that will injure cultivated row crops.

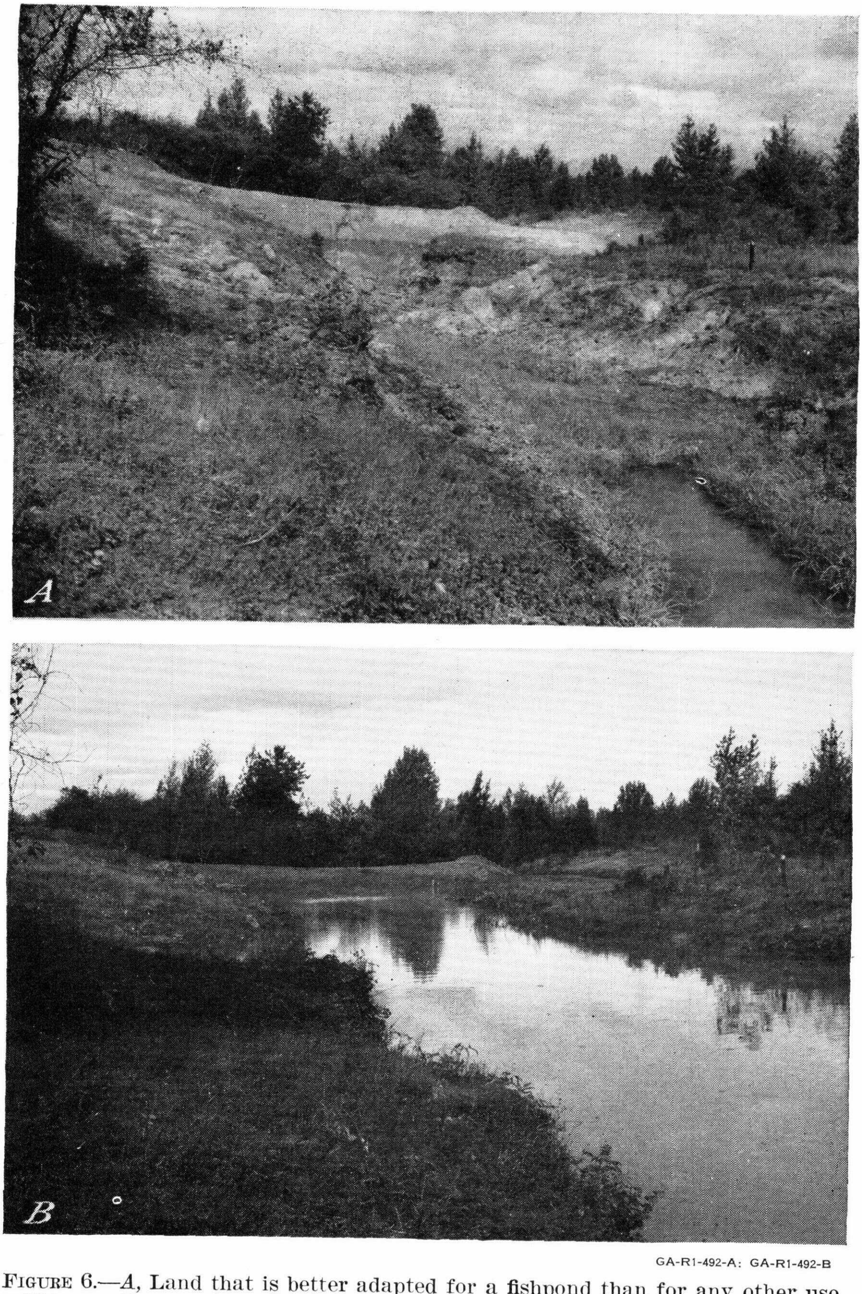
The height of the dam and the size of the pond will be influenced by the elevation at which a natural spillway exists or where one can be constructed safely. A dam should not be raised at the sacrifice of a good spillway site just to increase the size of a pond. Two or more ponds make an excellent arrangement for stocking and harvesting fish in rotation so that at least one pond will have mature fish all the time. Two small dams are often built at less cost than a large one to provide the same area of water.

As a fairly uniform water level is desirable, particular attention should be paid to the source of water. The supply may come from springs or from flowing wells, streams, or from the run-off of terraced fields, pasture land, or wooded areas. Few people think of ponds supplied only by run-off as being desirable for fish, but surprising as it may seem, they make good ponds. Of course the run-off must be sufficient to replenish waters lost by evaporation and seepage; and to keep it free from silt, conservation measures must have been applied to the watershed. When it is borne in mind that run-off from fertile land contains much natural fertility and so needs less commercial fertilizer, its value is more easily understood.

Where small streams, wells, or springs provide the water supply, a pond depth of 6 feet may be sufficient, although 8 feet of water would be much better. On the other hand, where the only supply is run-off from terraced fields, or from woodland or pastures, a depth of 8 feet or more must be planned for the pond, since the water level will fluctuate from season to season.

The best pond site on a farm is sometimes without water but within easy reach of a small stream that can be diverted into the basin. Water brought into the pond from a stream can be carried by a ditch, which should have only enough fall to carry the water adequately and not enough to cause erosion. Some type of control gate will have to be used at the head of the diversion ditch where it leaves the stream, to prevent flood waters or muddy water from entering and damaging the ditch and the pond. Screens must be placed at the intake end of the ditch in order to exclude suckers, catfish, or other undesired fish.

A 1-acre pond without a live water supply will require a watershed of 25 or more acres of fields or pasture to furnish sufficient run-off. In woodland this figure would need to be increased to 40 or more acres as the run-off is less. It should be kept in mind that a small pond, with



GA-R1-492-A; GA-R1-492-B

FIGURE 6.—*A*, Land that is better adapted for a fishpond than for any other use. This small-pond site has desirably steep sides and a gradually sloping floor. *B*, When filled, this pond has almost no shallow water. Notice the height above water of the completed dam and the wide level spillway at the right.

an area of 1 or 2 acres, located on a site fed by floodwaters from a large watershed or by a large continuous stream flow, is more difficult to manage properly because a large quantity of fertilizer is lost in water that goes over the spillway, fish are able to leave or enter the pond, and the flood danger is greater.

An ideal pond site, then, should be selected to insure:

1. A good reservoir in which to impound water.
2. A water supply as uniform as possible.
3. A depth of at least 6 feet where the water level fluctuates very little; and a depth of 8 feet or more where the water fluctuates some from season to season.
4. A moderately small watershed, to avoid flood problems, and one that is protected so as to keep run-off waters free of silt.

In the interest of malaria control most State health departments in the South require a permit before the building of a pond is begun. These permits require nothing that will interefere with good pond management, and no charge is made for the permit or for inspecting the pond.

SURVEYING THE SITE

The work of surveying the site is made easy if trees, shrubs, and bushes are first cut from the area that is to be covered with water. The removal of debris also is an important aid in controlling mosquitoes and water weeds; it prevents leaves and dead branches from clogging the spillway and makes it possible for bass to keep down an overpopulation of fish.

A strip at least 15 feet wide around the pond should also be cleared. All vegetation should be cut close to the ground and removed or burned. It is not necessary to dig or burn low stumps from the banks or water area, as long as they do not interefere with dam construction or project above the water surface when the pond is flooded.

The area is now ready to be surveyed and staked all around the pond at the normal water level to determine the exact depth. If it appears that large areas will be under less than 2 feet of water, the water level should be raised or lowered to maintain sufficient depth. If this fails to reduce the areas of shallow water substantially, a new site should be selected.

INSTALLING THE DRAIN PIPE

Every pond should be provided with a good drain so that it can be renovated and restocked, if it ever becomes necessary to do so. Almost any kind of unfavorable development, such as an overpopulation of small fish, can be corrected if a drain has been placed beneath the dam.

Cast-iron or galvanized wrought-iron pipes make good drains. A new product known as asbestos-cement pipe is coming into use. It is durable, can be purchased at a reasonable price, and is easily handled. Clay tile is difficult to use, as the weight of the settling earth in the new dam tends to crack the joints.

Pipe 3 or 4 inches in diameter will drain small ponds if the incoming flow is negligible. Small pipes, however, drain a pond slowly and tend to become clogged. If the fish are to be harvested by draining, a pipe 6 inches in diameter or larger should be installed.

Probably the most satisfactory control for the drain is a tipping pipe. This consists of a 90° elbow screwed onto the end of the drain in the pond and a section of pipe long enough to reach to the water level

screwed into the elbow. In draining the pond, this tipping pipe is turned over to one side until most of the water drains out; then the pipe is unscrewed, and the rest of the water and fish are removed from the pond. An application of white lead to the pipe threads prevents rusting. When the tipping pipe is upright, the top should be 3 or 4 inches lower than the spillway to allow a trickling flow through the pipe instead of over the spillway.

The drain must be placed so as to insure complete drainage of the pond. If the installed pipe leaves undrained pockets behind the dam, most of the fish will collect in these as the water is lowered. Mud makes it difficult to recover the trapped fish. The perfect drain is placed so that the last bucketful of water and all the fish are brought through the pipe and can be collected below the dam. The length of pipe needed will depend on the base width of the dam and the depth of the pond.

If a small auxiliary pond for holding fish is built, it also should be provided with a drain pipe.

BUILDING THE DAM AND THE SPILLWAY

The height and size of the dam will depend on the location of the spillway, the top width of the dam, and the slope of its sides. The character of the soil at hand influences the slopes that will be needed. In soils that contain considerable clay, slopes of 2½ : 1 on the upstream and 2 : 1 on the downstream sides are desirable for low dams (up to 15 feet high). The dams should have a minimum top width of 7 feet, if good material is available for construction, and a minimum top width of 10 feet if less desirable material must be used. A 2 : 1 slope means that the base is measured outward 2 feet for each foot that the dam will measure in height. In sandy and loamy soils and for dams exceeding 15 feet in height a 3 : 1 slope on the upstream and a 2 : 1 slope on the downstream sides are necessary. Dams with steeper slopes than these on either the upstream or downstream side demand frequent repair or may give way entirely. The most common fault in constructing earthen dams is that the base is not made wide enough to allow for adequate slopes.

A dam must have sufficient height above the normal water level to prevent water from overtopping the dam and washing it out during sudden or heavy rains. A 2-foot minimum is recommended, and for dams exceeding 12 feet in height this should be increased to 3 feet or more. If a dam is to be built on a stream that has a large watershed area and rises several feet during flood periods, it would be desirable to obtain technical assistance in designing the dam and spillway.[5] When construction is begun, the dam should be staked to indicate its height, upper and lower toes, and top width before any soil is moved. Any farmer can figure the base width and stake out a satisfactory dam by the following method:

Assume that a site shows the most logical location of the spillway mouth to be 6 feet above the lowest point in the valley floor at the center line of the proposed dam. This would require an 8-foot dam at the center line as the top of the dam is to be 2 feet above the

---

[5] For further information see: HAMILTON, C. L., and JEPSON, H. G. STOCK-WATER DEVELOPMENTS; WELLS, SPRINGS, AND PONDS. U. S. Dept. of Agr. Farmers' Bul. 1859, 70 pp., illus. 1940. NATIONAL RESOURCES COMMITTEE. LOW DAMS, A MANUAL OF DESIGN FOR SMALL WATER STORAGE PROJECTS. 431 pp., illus. Washington. 1938.

spillway level. Suppose a 7-foot top width is desired, with a $2\frac{1}{2}:1$ slope on the upstream side and a $2:1$ slope on the downstream side of the dam. The builder would start at the lowest center stake and measure upstream $3\frac{1}{2}$ feet (half the top width), plus 20 feet (two and one-half times the height of the dam), which locates the upper toe $23\frac{1}{2}$ feet upstream from the center stake. Measuring downstream $3\frac{1}{2}$ feet (half the top width), plus 16 feet (two times the height of the dam) locates the lower toe $19\frac{1}{2}$ feet below the center stake—a total bottom width of 43 feet.

In setting stakes for the upstream and downstream toes of the dam to guide the placing of soil as the height increases, allowance must be made for changes in elevation since higher up the slope the height of the dam and its base width will be less.

A good spillway is just as important as a good dam. The spillway problem is twofold: First, the spillway must be wide enough to carry floodwater out of the pond without danger to the dam; and, second, the spillway must lower the water from the pond down to the bottom of a stabilized draw without creating an overfall which will eventually cut a channel through the spillway around the dam. If the watershed exceeds 50 acres, an experienced builder of ponds should be consulted.

A wide spillway allows floodwaters to leave the pond as a shallow stream in which the loss of fish is negligible. Even though deeper flows may allow more fish to leave the pond, a fish screen across the spillway is not recommended, as screens clog with debris and become a serious hazard to the security of the dam.

If a natural spillway is not available, one can be cut from the hillside at either end of the dam. If a large spillway cannot be built at one end, smaller ones can be built at each end to accommodate the water that would ordinarily be carried by a large spillway. Erosion of the spillway floor can be prevented by a good sod of grass. The soil which is removed in shaping spillways should be used in building the dam. In sandy soils it may be necessary to build a concrete drop outlet in the spillway in order to get both the normal water and floodwaters to a safe level.

A raw open bank must not be left on the side of a spillway as erosion will cause silting of the spillway channel. Sericea lespedeza is best adapted for holding the soil in place here. The slope of the bank should be no steeper than 2:1. The bank should be plowed, fertilized, and mulched before being seeded.

A good foundation for the dam should be prepared before piling loose earth on the site. This is accomplished by removing all stumps, roots, vegetation, and trash and then scooping away the topsoil. This scooped-off area should then be broken with a turning plow to insure a good "seal" between the old earth surface and the new fill.

If the dam is to be built of sandy soils, a core wall of heavy clay will be needed to reduce seepage of water through the completed dam. A core wall is constructed by digging, scooping, or blasting a trench down to good foundation the length of the dam at its center. This is filled with heavy clay and carried to water-level height as the sandier soil is used to build the dam on each side.

The tools at hand will largely determine the way to move the soil. Teams and drag pans are commonly used and produce a well-packed dam. Bulldozers, rotary scrapers, or drag pans powered by tractors,

steam shovels, or trucks are faster and are particularly suitable for larger construction jobs.

An additional foot of soil must be added to the top for each 10 feet of dam height to allow for settling. Settling is sometimes greater at one point than at others, and more soil will be needed to even up the top so that the dam will have no low places in it. It is desirable to construct the fill in uniform layers of earth 5 to 10 inches deep, keeping each layer as nearly level as practicable and completing one before starting the next. Moist soil makes a well-compacted fill. While it is desirable to obtain soil from the pond basin for the dam, none should be removed in such a manner as to leave a pocket that cannot be drained.

The dam should be sprigged with Bermuda grass or seeded with a standard pasture mixture or other adapted type of vegetation. If the pond is large or is located in an unprotected place where wave action will cause damage, the upstream side of the dam should be riprapped for 2 or 3 feet above and below the normal water level. Rocks or pieces of broken concrete large enough to stay in place serve well. Logs, wired in place, give temporary protection where other materials are not available.

DEEPENING THE EDGES

Waters less than 2 feet deep present several problems of maintenance and utilization and are of little or no value for fish. Almost every pond can be made more suitable for fish production by deepening and diking to reduce the areas of shallow water. Soil from shallow areas near the dam should be used in building the dam. At points beyond convenient hauling distance to the dam, areas over which the water would otherwise be less than 2 feet deep may be deepened by the following method: (1) Stake the natural water line and the contours at 1- and 2-foot depths; (2) plow and remove soil from the lower half; and (3) dump the soil on the upper half to fill in where the natural depth would have been 12 inches or less (fig. 7). This brings the new water line approximately to the position of the 1-foot contour, but they need not coincide exactly. Smooth curving lines should be left for pleasing appearance. This method is most efficient where the slope between stakes is not less than 6 or 8 percent, and is unnecessary on slopes exceeding 25 or 30 percent.

The drainage entrance at the upper end of a pond, however, often slopes quite gently. In such cases the area to be filled is wide; therefore, a straight dike is easier to throw up, the soil being taken from the pond basin below. A good point of location for this dike is at the 2-foot depth unless a narrower place is available nearby. The dike must have a foot or so of freeboard to prevent floodwater from overtopping it. Floodwater is allowed to enter the pond around both ends of the dike. These miniature spillways should empty over the natural water line to prevent cutting. The unfilled area above the dike acts as a settling basin for heavy silt and through siltation will eventually become suitable for pasture grasses.

The benefits of deepened edges for ponds are briefly listed as follows:

1. Weeds, as cattails and waterlilies, that grow in shallow water are easily controlled when the shallow area is narrow enough so that they can be removed with a potato fork or a garden rake.

2. Bass are able to cut down the numbers of forage (noncarniverous) fish so that a higher percent of the total weight is in legal-size fish. (There is no danger of eliminating reproduction or reducing the small fish too severely. On the other hand water weeds always protect too many young.)

3. The waters that may be fished from the bank are more than doubled. The entire edge becomes suitable for both bream and bass fishing, whereas ordinary construction would leave only the end near the dam favorable for fishing.

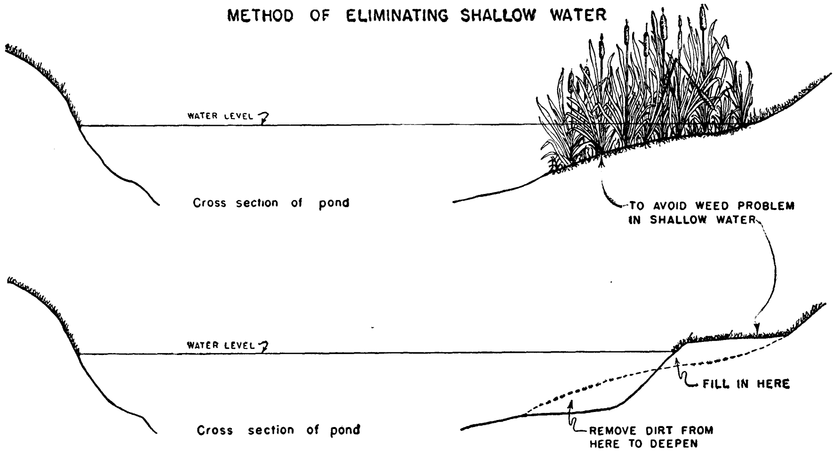


FIGURE 7.—Pond edges should be deepened in order to control emergent water plants and improve fishing.

4. Evaporation is reduced in proportion to the reduction of surface area. Infiltration or seepage will also be reduced somewhat, and the water level kept from extreme fluctuation.

5. Wading of cattle and wallowing of hogs is materially curtailed, thus reducing the muddying of the water and interference with spawning in ponds that are not fenced against livestock.

6. On many pond sites that are suitable in every other way, ponds can be constructed successfully only by the application of this principle. By throwing up dikes, ponds can also be built on flat bottom land between a stream on one side and almost any kind of slope on the other.

THE FINISHED POND

The finished pond should have the following features:

1. A site selected on the basis of good land use, since it is not advisable ordinarily to flood lands needed for other purposes.

2. Steep sides and a gradual slope up the draw, with areas where the water is less than 2 or 3 feet deep eliminated insofar as possible, and a depth of from 6 to 8 feet if the water level remains constant or an 8- or 10-foot depth if the water level fluctuates from season to season.

3. An adequate water supply. Water from terraced field, woodland, or pasture is satisfactory if the run-off is virtually silt-free, as, of course, is the water from springs, wells, or very small streams.

4. Water area and a 15- or 20-foot strip around the edge from which all trees, shrubs, and debris have been removed.

5. A permanent drain pipe so placed that all the water can be drained out of the pond and large enough to allow at least the smaller fish to pass through the pipe and be caught below the dam, where they can be sorted for future use.

6. A well-built dam and an adequate spillway to prevent damage by floodwaters.

PROTECTING THE POND WATERSHED

A pond fed by an eroding watershed is practically worthless for fish production. Often more than half the rainfall on eroded land runs off and carries a load of soil as it rushes down the slope. Bare or lightly vegetated slopes are the birthplace of floods and silt. As land continues to erode it becomes less fertile and subsequently decreases the fertility of the water entering the pond. A good cover of vegetation protects and holds the soil in place and reduces floods by allowing more of the rain to filter into the soil. When fed from a watershed on which adequate soil conservation practices have been applied, a pond receives water which is essentially silt-free, contains considerable natural fertility, and causes little, if any, flood damage.

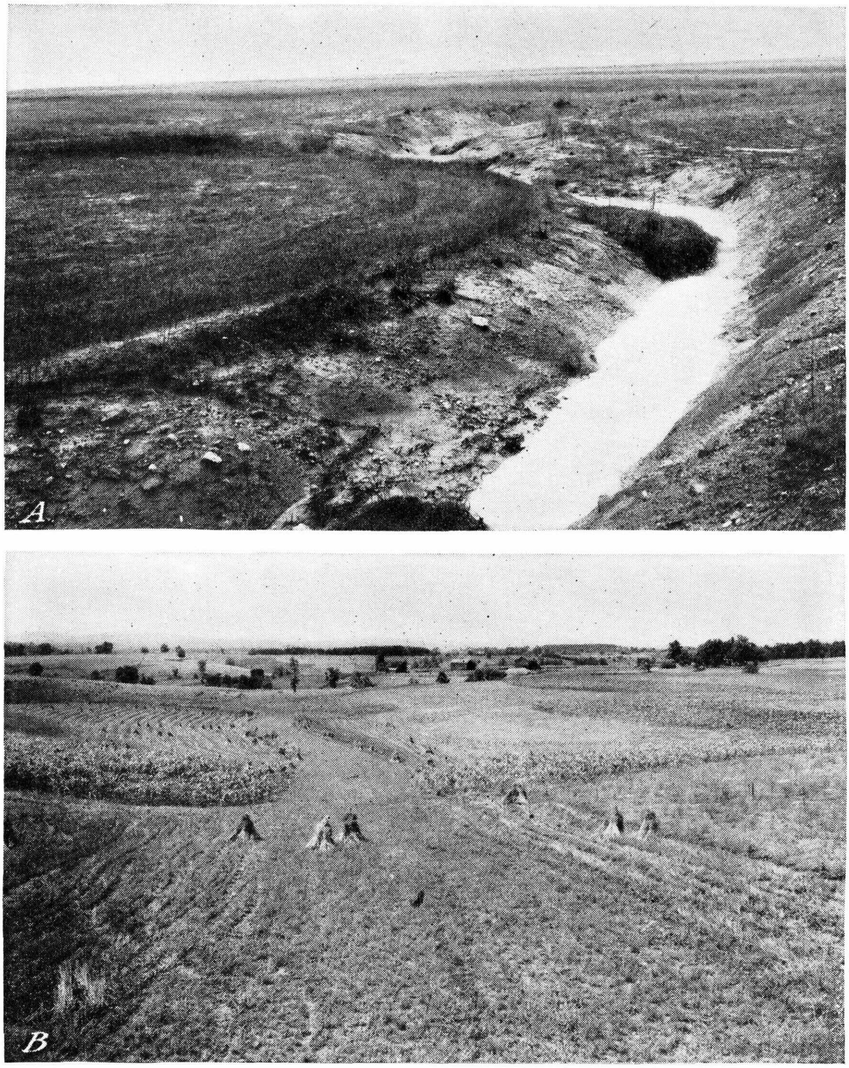
Although limited control of silting may lengthen the pond's life somewhat, it will still fail to produce a full crop of fish if the amount of light soil particles carried by run-off water into the pond is not held to a minimum. This is particularly true where clay soils predominate in the watershed, chiefly because fish cannot obtain sufficient food in permanently muddy water, as is explained in the section on Foods of Bream and Bass. Thus, for farms that are surrounded by clay soils the best solution of the silting problem is effective erosion control on the entire watershed. This has been accomplished to the profit and satisfaction of many farm communities, by the cooperative effort of neighbors.

WHERE TO CONTROL EROSION

Soil conservation entails using every parcel of land for the purpose for which it is best suited and employing the necessary cultural practices. In order to protect the pond against damage from erosion, soil conservation practices will be needed on the watershed of the pond whether the land is used as cropland, hay land, wildlife land, pasture, woodland, roads, or any combination of these.[6] Diverting silt-laden waters from the pond is not recommended, for erosion and run-off are most effectively controlled at the source. Sloping croplands need a complete system of crop rotations, cover crops, contour cultivation, terraces, and meadow outlets. These practices reduce sheet erosion, prevent gullies, provide vegetation to strain silt from excess waters as they drain down the slope, and permit more rainfall to filter into the soil (figs. 8 and 9).

---

[6] These practices are discussed in detail in the following publications: WELD, W. A., and PRICE, P. M. TERRACE CONSTRUCTION WITH SMALL EQUIPMENT IN THE SOUTH. U. S. Dept. Agr. [Unnum. Pub.], [12] pp., illus. 1940; DOWNING, J. M., and PRICE, P. M. PLOWING FOR TERRACE MAINTENANCE IN THE SOUTH. U. S. Dept. Agr. [Unnum. Pub.] [9] pp., illus. 1940; TOWER, H. E., and GARDNER, H. H. STRIP CROPPING FOR WAR PRODUCTION. U. S. Dept. Agr. Farmers' Bul. 1919, 48 pp., illus. 1942; BAILEY, R. Y. KUDZU FOR EROSION CONTROL IN THE SOUTHEAST. U. S. Dept. Agr. Farmers' Bul. 1940, 32 pp., illus. 1939; and DAVISON, V. E. PROTECTING FIELD BORDERS. U. S. Dept. Agr. Leaflet 188, 8 pp., illus. 1941. Revised.

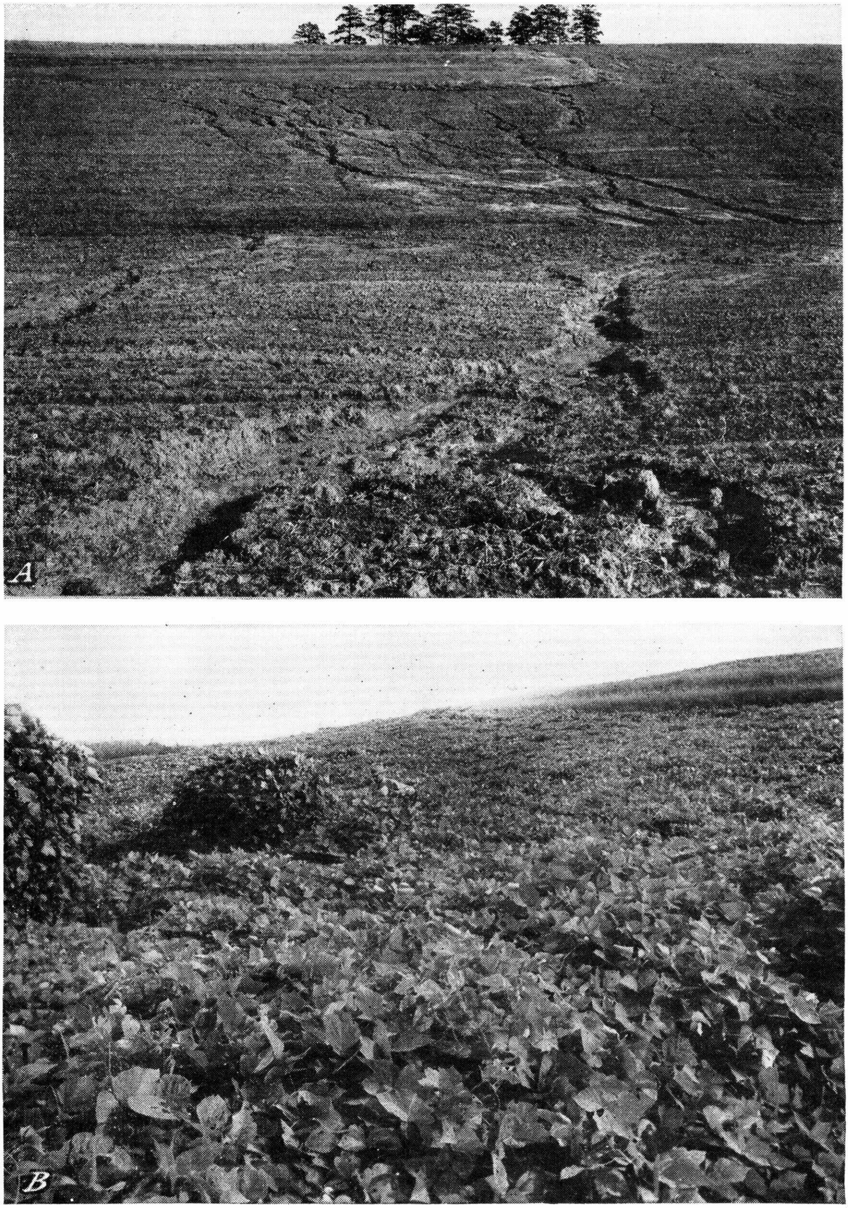


GA-R1-559 VA-30,147

FIGURE 8.—Soil-conserving practices prevent silting of ponds. *A*, A meadow strip is needed. *B*, A meadow strip in relation to terraces and crops rotated in contour bands.

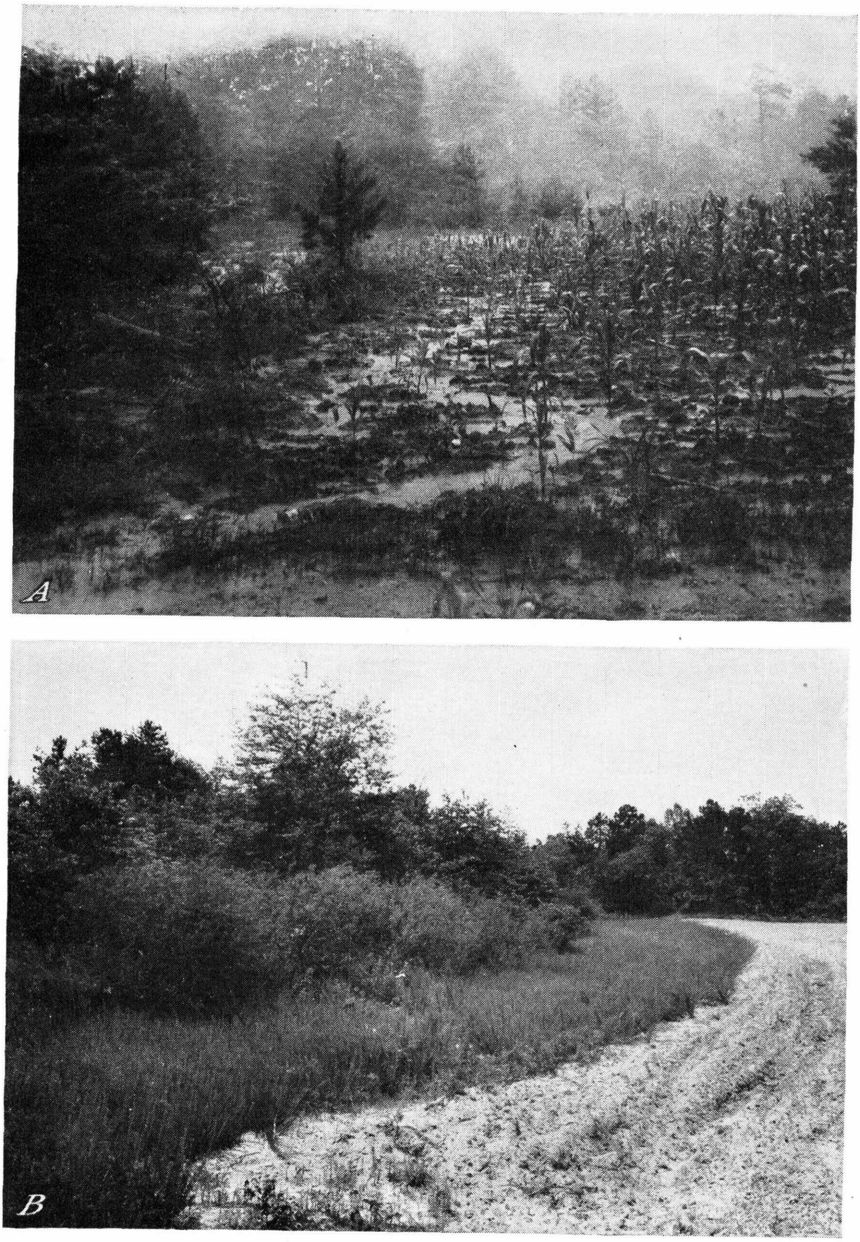
Soil conservation measures prevent the movement of heavy soil particles and greatly reduce the quantities of lighter soil materials that are carried from the land by run-off water. The building of a pond should therefore be delayed until adequate soil conservation practices have been established. If the land in the watershed is poor and eroded, it may require 2 or more years of conservation treatment before a dam can safely be constructed.

Unless protected by borders of close-growing vegetation, contour rows concentrate water at the edge of fields, where it carries freshly



NC-R1-15 R-2-212

FIGURE 9.—A, Critical slopes, when clean tilled, erode and become unproductive. *B*, Kudzu or sericea lespedeza is a suitable perennial to hold soils in place, increase fertility, and produce excellent hay.



R-2-309 SC-D3-153

FIGURE 10.—A, The unproductive edge of a field supports practically no crop and permits serious erosion. *B*, Wildlife borders of shrubs and sericea lespedeza solve border problems for southern farmers.

plowed soil down the slopes with every heavy rain (fig. 10, *A*). In addition to this protection from erosion, a border furnishes a turnrow, keeps trees from encroaching on the cultivated land, and establishes desirable cover and food for songbirds, quail, and rabbits.

Erosion and run-off are most effectively controlled at the source. Good pastures strain silt from waters which flow across them. Figure 11 shows the advantage of appropriate treatment for woodlands

NC-20,080 VA-255

FIGURE 11.—*A*, Woodland gullies develop when fires, grazing, and concentrations of water from other areas remove protective ground litter. *B*, The litter that accumulates on the ground, rather than the trees or their roots, most effectively controls the erosion.

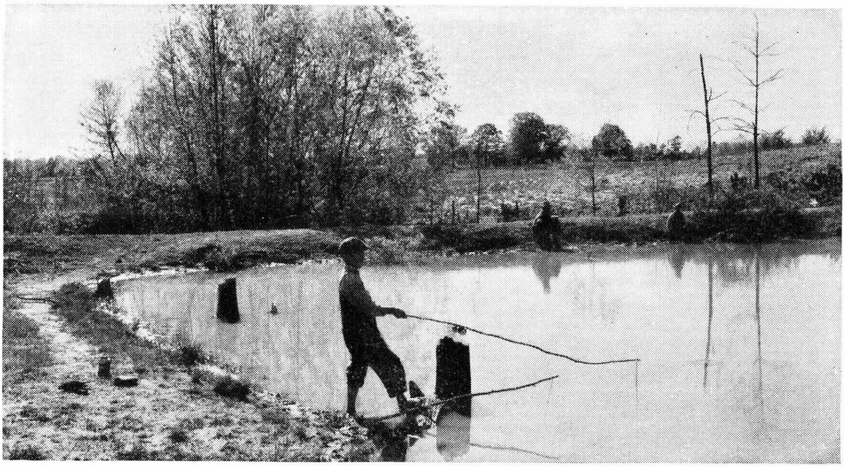
whereby erosion and the movement of silt may be arrested. Erosion control along public roads will require the assistance of county and State officials, but individual farmers can help by protecting the sides of roads along their own property lines.

OLD PONDS AND LARGER LAKES

Owners of old ponds (fig. 12) will find it worth while to follow management measures recommended for new ponds. Old ponds should first be drained and all fish removed; an adequate drain pipe installed; the spillway made to conform with desirable specifications;

existing debris removed from the banks and pond area; water weeds, if present, destroyed; and shallow areas deepened, filled in, or diked out. Then the pond can be refilled, stocked, fertilized, and managed as recommended for a new pond. Old ponds should be fertilized a week or two before being stocked because natural fertility is usually low.

Larger lakes can be constructed and managed intensively as a business venture by clubs or groups of farmers. Anyone with sufficient capital to meet the expense of construction and fertilization might sell enough fishing rights to make a profit and thereby remove most of the usable fish as fast as they reach proper size.



MISS-60,371

FIGURE 12.—Old muddy ponds where there is no longer good fishing can be improved by being drained, reconditioned, and restocked, and by following the management methods recommended for new ponds.

The problems connected with managing large reservoirs are many, however. Erosion, floods, and siltation are serious hazards on large watersheds; dam and spillway construction require considerable engineering skill; large initial stocks of fish are difficult to obtain; removing water plants and keeping the banks in condition involve hiring extra labor; and the cost of fertilization and management must be compensated for by intensive use, which means added problems of organization to direct the large number of people who must be accommodated.

On the other hand, individual farmers can build and manage small ponds with ordinary farm equipment and materials, thus avoiding most of the problems connected with larger lakes. Erosion and floods are controlled on the small watersheds by good farming measures; the dam and spillway are simple to design and construct; the correct number of fish are easily obtained; removing water plants and keeping the banks in good condition are hardly more than a pastime, and the quantity of fish produced as a result of fertilization and management can be profitably and pleasurably used by the farm family.

U. S. GOVERNMENT PRINTING OFFICE: 1943